Attorney's Docket No. 1016660-000038

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

Oscar Chi-Lim AU et al.

Application No.: 09/512,378

Filed: February 25, 2000

For: ENHANCING AN IMAGE, SUCH AS AN IMAGE HAVING BI-VALUED PIXEL VALUES

Group Art Unit: 2625

Examiner: JAMES A. THOMPSON

Appeal No.: ______________

APPEAL BRIEF

Mail Stop APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This appeal is from the decision of the Primary Examiner dated September 25, 2006, rejecting claims 1-9 and 11-22, which are reproduced as the Claims Appendix of this brief.

☐ A check covering the ☐ $ 250 ☐ $ 500 Government fee is filed herewith.

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The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§1.16, 1.17, and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800.

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Table of Contents

I. Real Party in Interest

The present application is assigned to The Hong Kong University of Science and Technology, of Clearwater Bay, Kowloon, Hong Kong.

II. Related Appeals and Interferences

There are no known prior or pending appeals, interferences or judicial proceedings which may be related to, directly affect or be directly affected by, or have a bearing on the Board's decision in this appeal.

III. Status of Claims

The application contains claims 1-22. Claim 10 has been canceled. Claims 1-9 and 11-22 are pending, and stand rejected. This appeal is directed to each of the rejections of claims 1-9 and 11-22.

IV. Status of Amendments

There were no amendments filed subsequent to the Office Action dated September 25, 2006.

V. Summary of Claimed Subject Matter

The claimed subject matter is directed to the enhancement of images on a pixel-by-pixel basis. As described in the background portion of the application, one exemplary application of the invention is a process known as "inverse half toning", in which binary pixel values for an image are converted into values within a continuous range, e.g. 0-255. Preferably, this method is carried out in an iterative fashion, in which a pixel value resulting from one iteration is updated in a successive iteration. (Page 3, lines 18-25). The updating that occurs during each iteration is succinctly described by the equation set forth on page 6, line 28 of the application, namely:

$$y^{m+1}(i,j)=\Sigma_{(k,l)\varepsilon Nm+1(i,j)}a_{ij}{}^{m+1}(k,l)y^{m}(i+k,j+l).$$

In this procedure, $y^m(i,j)$ is the converted value of the pixel at location (i,j) after iteration m. (Page 6, lines 12-16) The indices k and l designate pixels in a neighborhood containing y(i,j), e.g. a 3x3 grid. (Page 6, lines 17-25). The term $a_{ij}(k,l)$ represents a weighting value for a corresponding pixel in the neighborhood, which reflects the likelihood that a neighboring pixel at position (k,l) is correlated with the pixel of interest at position (i,j). (Page 5, line 31 to page 6, line 2). This value is also called a significance coefficient in the application. (Page 2, lines 18-26).

The calculation of the weighting value a_{ij} is described in the equations appearing on page 7, lines 20-25 of the application. These equations, in turn, require the calculation of two values, namely f(v) and w(i,j). With respect to the baseline value w(i,j), page 7, lines 11-12 disclose that this value could be the same as the value y(i,j) of the pixel being updated. The specification goes on to disclose that, more preferably, the baseline value is a function of y(i,j) in which high frequency components are reduced, "such as an average over the pixels neighboring (i,j)." (Page 7, lines 12-14).

The application sets forth four specific examples for the function f(v), at page 13, lines 3-10. Tables 5-7 appearing on pages 13-16 provide specific results that are obtained with each of these different functions, for each of the three different neighborhood functions of Figures 4a-4c, and different values for the parameter "k".

The application contains seven independent claims, namely claims 1, 2, 13, 14, 16, 17 and 22. Claim 1 recites a method for converting a halftone image into a continuous-valued image that includes the initial step of, for each pixel, defining a neighborhood that contains that pixel and other pixels. (Page 13, lines 12-19). The claim further recites the steps of obtaining a continuous value for each individual pixel "by summing the products of weighting values and the ... values of the pixels in the neighborhood of the individual pixel." (Page 6, lines 17-31). During the initial iteration (m=0), the pixel values are the binary halftone values (page 2, lines 24-26), and in subsequent iterations the pixel values are the continuous values obtained from a previous iteration (page 3, lines 18-21).

A mapping of each of the other independent claims to the disclosure is set forth in the following claim charts.

Claim	Disclosure
2. A method for converting a halftone image having a halftone value for each of a plurality of pixels, into a reconstructed image which for each of said pixels takes on one of more than two possible values, comprising for successive individual pixels:	Page 1, lines 5-9
defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;	Page 6, lines 17-25; Page 13, lines 12-19
deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel; and	Page 6, line 33 to page 7, line 28
deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the halftone image value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.	Page 6, lines 26-31
13. A method for converting a halftone image having a binary value for each of a plurality of pixels, into a reconstructed image which for each of said pixels takes on one of more than two possible values, comprising for successive individual pixels:	Page 1, lines 5-9
defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;	Page 6, lines 17-25; Page 13, lines 12-19
deriving for each pixel of said first neighborhood, a respective significance coefficient;	Page 6, line 33 to page 7, line 28
deriving a first reconstructed value of the individual pixel as a sum over the neighborhood pixels of a product of the halftone image value at that neighborhood pixel with the respective significance coefficient of that neighborhood pixel; and	Page 6, lines 26-31
M further steps, m=1,..., M (M≥1), of: for successive individual ones of said pixels: rederiving a significance coefficient for each neighborhood pixel; and	Page 6, lines 12-13; Page 3, lines 18-19
deriving an (m+1)-th reconstructed value of the individual pixel as a sum over the neighborhood pixels of the product of the m-th reconstructed value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.	Page 3, lines 19-21

14. A method for converting a halftone image having a halftone value for each of a plurality of pixels, into a reconstructed image which for each of said pixels takes on one of more than two possible values, comprising:	Page 1, lines 5-9
preprocessing the halftone image by a filtering algorithm to derive a preprocessed image having a preprocessed image value for each of said pixels;	Page 4, lines 6-8
for successive individual pixels: (i) defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;	Page 6, lines 17-25; Page 13, lines 12-19
(ii) deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel;	Page 6, line 33 to page 7, line 28
(iii) deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the preprocessed image value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.	Page 6, lines 26-31
16. A method for enhancing first image having a first value for each of a plurality of pixels, into an enhanced image, comprising for successive individual pixels:	Page 1, lines 5-9
defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;	Page 6, lines 17-25; Page 13, lines 12-19
deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel	Page 6, line 53 to page 7, line 28
deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the first value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.	Page 6, lines 26-31
17. A method for enhancing a first image having a first value for each of a plurality of pixels to form an enhanced image, comprising:	Page 1, lines 5-9
preprocessing the first image by a filtering algorithm to derive a preprocessed image having a preprocessed image value for each of said pixels;	Page 4, lines 6-8

for successive individual pixels: (i) defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;	Page 6, lines 17-25; Page 13, lines 12-19
(ii) deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel;	Page 6, line 33 to page 7, line 28
(iii) deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the preprocessed image value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.	Page 6, lines 26-31
22. An image enhancement apparatus for converting a first image into an enhanced image, comprising a processing device having:	Page 1, lines 9-11; Page 5, lines 10-14
an image receiver for receiving said first image;	inherent in a computer that processes an image
and an image processor which performs the steps of: for each pixel, defining a respective neighborhood containing that pixel and other pixels;	processor inherent in a computer; Page 6, lines 17-25; Page 13, lines 12-19
in a first iteration, obtaining for each individual pixel a continuous value by summing the products of weighting values and the binary values of the pixels in the neighborhood of the individual pixel, the weighting values being derived from the values of the first image;	Page 2, lines 24-26; Page 6, lines 26-31
in further iterations, obtaining for each individual pixel a continuous value by summing the products of the weighting values and the continuous values of the pixels in the neighborhood of the individual pixel obtained at the previous iteration, the weighting values being derived from the continuous values obtained in at least one previous said iteration.	Page 3, lines 18-21

VI. Grounds of Rejection to be Reviewed on Appeal

The Office Action presents 14 grounds of rejection, each of which is presented for review on this appeal. The rejections are as follows:

A. The following sets of claims stand rejected under 35 U.S.C. §101 as being directed to non-statutory subject matter:

1. Claims 1 and 18
2. Claims 2-9, 11, 12 and 19
3. Claims 13 and 20
4. Claims 14, 15 and 21
5. Claim 16
6. Claim 17

B. Claim 22 stands rejected under the first paragraph of 35 U.S.C. §112, as failing to comply with the enablement requirement.

C. The following sets of claims stand rejected under the second paragraph of 35 U.S.C. §112 as being indefinite:

1. Claims 2-9, 11, 12 and 19
2. Claims 14, 15 and 21
3. Claim 16
4. Claim 17

D. Claims 2-4, 16 and 19 stand rejected under 35 U.S.C. §102, as being anticipated by the *Fan* patent (U.S. 6,101,285).

E. Claims 1, 5, 11-15, 17, 18 and 20-22 stand rejected under 35 U.S.C. §103 as being unpatentable over the *Fan* patent in view of the *Wong* patent (U.S. 5,506,699)

F. Claims 6-9 stand rejected under 35 U.S.C. §103 as being unpatentable over the *Fan* patent in view of the *Wong* patent "and obvious engineering design choice."

VII. Argument

A. Rejections under 35 U.S.C. §101

1. Claims 1 and 18

Claims 1 and 18 are rejected under 35 U.S.C. §101, on the grounds that they are directed to non-statutory subject matter. The rejection states "claim 1 recites a method which is merely an algorithm that is performed on descriptive data, namely stored pixel values...Thus, claim 1 does not have a substantial practical application since claim 1 is merely an algorithm that manipulates information." The rejection goes on to characterize the subject matter of claim 1 as "an abstract idea, and not a process, machine, article of manufacture, or composition of matter..."

Claim 18 was rejected on the ground that it depends from claim 1, "and is also merely an algorithm which manipulates descriptive data."

The fundamental underpinning of the rejection appears to be that, since the claimed method involves the processing of data, it is not directed to a practical application, and therefore merely encompasses an abstract idea. However, this position is not supported by either the statute itself, or the pertinent case law. Claim 1 is not directed to the manipulation of *any* kind of data. Rather, it is directed to the processing of pixels, to convert a halftone image into a continuous value image. As such, it is directed to a practical, i.e., real world, application of the algorithms disclosed in the specification.

The fact that the individual pixels can be represented by data does not automatically transform the subject matter into an abstract idea. See *Arrhythmia Research Technology v. Corazonix Corp.*, 958 F.2d 1053, 22 USPQ2d 1033 (Fed. Cir. 1992). "[T]he number obtained is not a mathematical abstraction; it is a measure in microvolts of a specified heart activity.... That the product is numerical is not a criterion of whether the claim is directed to statutory subject matter." 958 F.2d at 1060, 22 USPQ2d at 1039. Likewise in the present case, the pixel data is representative of real-world phenomena, e.g. colors, intensity, transparencies, etc. in an image. That data controls the reproduction of the image on a printer or display device. Appellants are not claiming the algorithm in the abstract, but rather in the

context of a specific, practical application, namely the enhancement of a concrete image.

The cases cited in the Office Action do not support the rejection. In *Gottschalk, Comr. Pats. v. Benson*, 409 U.S. 63, 175 U.S.P.Q. 673, (1972), the Supreme Court stated "the mathematical formula involved here has not substantial practical application except in connection with a digital computer, which means that if the judgment below is affirmed, the patent would wholly pre-empt the mathematical formula and in practical effect would be a patent on the algorithm itself." In *Diamond, Comr. Pats. v. Diehr and Lutton*, 450 U.S. 175, 209 U.S.P.Q. 1 (1981), the Supreme Court referred to its decision in the *Benson* case, and went on to state "a claim drawn to subject matter otherwise statutory does not become nonstatutory simply because it uses a mathematical formula, computer program or digital computer...It is now commonplace that an *application* of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection." 450 U.S. at 187, 209 U.S.P.Q. at 8. In the present case, Appellants are not attempting to *wholly* pre-empt the mathematical formula disclosed at page 6, line 28, for example. Rather, the claims are directed to a specific application of that formula, namely the conversion of pixels that define an image, to thereby enhance the image. As such, the claim lies within the scope of patentable subject matter defined in 35 U.S.C. §101. Specifically, the claim defines a "process", which is one of the stated categories of patentable subject matter.

The rejection appears to be based upon the fact that claim 1 does not explicitly recite the generation of a physical hardcopy output of an image resulting from the method. However, the Office Action does not cite any support for such a requirement. It is to be noted that each of the two references cited in the prior art rejections, namely the *Fan* and *Wong* patents, contain method claims that are directed to the conversion of a binary, or halftone, image into a grayscale, or continuous tone, image. These claims do not recite the generation of a physical hardcopy output of an image. Likewise, the *Murakami et al.* patent (U.S. 5,268,771), applied in previous rejections, also contains method claims that do not recite the generation of a physical hardcopy output (see claims 36-41). If the rejection of claim 1 under 35 U.S.C. §101 is affirmed, the net effect would be to declare the method

claims of each of these three patents to be invalid on the same basis, as well as perhaps hundreds of other patents that are directed to image enhancement and other image processing techniques. Such a result would be contrary to the holding of the Federal Circuit in *Arrhythmia*.

The Patent & Trademark Office Guidelines relating to the eligibility of subject matter for patenting (reproduced at MPEP § 2106) refer extensively to the decision of the Federal Circuit in *State Street Bank & Trust Co. v. Signature Financial Group*, 149 F.3d 1368 (Fed. Cir. 1998). The holding in that case does not require the type of "result" that the rejection is asserting. In defining what is meant by a "useful, concrete and tangible result", the court stated:

> Today, we hold that the transformation of data, representing discrete dollar amounts, by a machine through a series of mathematical calculations into a final share price, constitutes a practical application of a mathematical algorithm, formula, or calculation, because it produces "a useful, concrete and tangible result" - a final share price momentarily fixed for recording and reporting purposes and even accepted and relied upon by regulartory authorities and in subsequent trades. (149 F.3d at 1373)

Hence, the useful, concrete and tangible result was identified to be "*a final share price momentarily fixed*", i.e. a number that has real-world significance. There was no reference to a need to print a physical hardcopy of the number in order for the claimed subject matter to be patentable under 35 U.S.C. § 101. The claims of the present application are no less worthy of patent protection. They recite a process that produces transformed pixel values, i.e. numbers representing physical phenomena. As such, they describe a "useful, concrete and tangible result".

In summary, claim 1 is not merely directed to an "abstract" idea that wholly pre-empts a mathematical formula. Rather, it is directed to a specific, practical application, namely the enhancement of a halftone image that is defined by pixel values. As such, it falls within the definition of patentable subject matter encompassed by 35 U.S.C. §101.

The rejection of claim 18 characterizes this claim as being directed to "merely an algorithm." However, claim 18 recites a "computer program product which is readable by a computing device" to cause the computing device to perform a method. As such, it is not directed to an algorithm, per se. Rather, it recites tangible

subject matter, namely a "product" that is functionally tied to the operation of a computer, i.e. it is "readable by a computing device to cause the computing device to perform a method." Consequently, the claim recites the program product in the context of a concrete, useful and tangible application.

2. Claims 2-9, 11, 12 and 19

Although the rejection of claims 2-9, 11, 12 and 19 under 35 U.S.C. §101 is set forth in the Office Action as a separate ground of rejection, the basis for the rejection is essentially the same as that for claims 1 and 18, discussed above. The Office Action states "In claim 2, a defining step, a significance coefficient deriving step, and a reconstructed value deriving step are performed on pixel data, *pixel data simply being internal digital data that represents values for pixels*." (emphasis added) The Office Action goes on to state that "These steps are clearly steps of a computer algorithm that are performed on a computer. . . . Thus, claim 2 does not have a substantial practical application since claim 2 is merely an algorithm that manipulates information."

As can be seen from the foregoing, the rejection is based upon the same premises as the rejection of claims 1 and 18. Specifically, it focuses upon the fact that the pixels are represented by data, and implicitly dismisses the manipulation of data as being non-patentable subject matter, regardless of what that data represents. Such a position is contrary to the holding of the *Arrhythmia* case. Furthermore, the rejection notes that the claim steps can be performed in a computer, and again employs this fact as a basis for dismissing their patentability, contrary to the holding in *Diehr*.

In stating that "Claim 2 is therefore directed to an abstract idea, and not a practical application, and would thus seek to patent the abstract idea itself . . .", the Office Action fails to appreciate that the claims are directed to a specific *application* of the algorithm, as opposed to the algorithm per se. The pixel data is not an abstract mathematical number, it is a numerical representation of the physical characteristics of an image.

3. Claims 13 and 20

The rejection of claims 13 and 20 is a repeat of the rejection of claims 2-9, 11, 12 and 19, with different claim numbers substituted therein. For the reasons presented in the preceding section of this Brief, the rejection of these claims is not supportable. Claims 13 and 20 are directed to a practical application of an algorithm, namely the processing of pixel data to convert a halftone image into a grayscale image, and do not wholly preempt the algorithm, in the abstract.

4. Claims 14, 15 and 21

The rejection of these claims again repeats the same ground of rejection as claim 2 and its dependent claims. Like the claims discussed previously, claim 14 recites a method of processing pixel data, to convert a halftone image into a grayscale image. As such, it is directed to a practical implementation of an algorithm, rather than the algorithm, per se.

5. Claim 16

The rejection of claim 16 is another repeat of the grounds of rejection set forth with respect to claim 2. Claim 16 also recites a process on real-world data, namely pixel values that define an image, and therefore falls within the realm of statutory subject matter contemplated by 35 U.S.C. §101, for the reasons set forth in the preceding sections.

6. Claim 17

The rejection of claim 17 is also a repeat of the grounds of rejection set forth with respect to claim 2. As with the claims discussed above, claim 17 recites a method for processing individual pixel values, to enhance an image. For the reasons discussed above, the subject matter of this claim falls within the scope of statutory subject matter encompassed under 35 U.S.C. §101.

B. The Rejection of Claim 22 Under 35 U.S.C. §112, First Paragraph

Claim 22 recites an image enhancement apparatus for converting a first image into an enhanced image. This claim stands rejected as failing to comply with the enablement requirement of the first paragraph of 35 U.S.C. §112. The Office Action states:

> Claim 22 recites an image processor which performs the steps of a method. . . . A processor cannot in and of itself perform any steps . . . . Some form of computer software encoded on a computer-readable medium is required in order to enable a computer processor, such as the claimed image processor, to carry out the steps recited in claim 22. Without such a recitation, claim 22 is not enabled by the specification.

The rejection appears to be asserting that, without explicit disclosure of "some form of computer software encoded on a computer-readable medium", the specification fails to provide a disclosure that would enable someone to make and use the apparatus recited in claim 22. However, the requirements of the first paragraph of 35 U.S.C. §112 are not that rigid. This paragraph of the statute states that "The specification shall contain a written description of the invention . . . in such full, clear, concise and exact terms so as to enable *any person skilled in the art to which it pertains, or with which it is most nearly connected,* to make and use the same." Thus, the statute requires that the disclosure be commensurate with the level of skill in the pertinent art.

The claimed invention is directed to the enhancement of images on a pixel-by-pixel basis. As described in the background portion of the application, one exemplary application of the invention is a process known as "inverse half toning", in which binary pixel values for an image are converted into values within a continuous range, e.g. 0-255. Preferably, this method is carried out in an iterative fashion, in which a pixel value resulting from one iteration is updated in a successive iteration. The updating that occurs during each iteration is succinctly described by the equation set forth on page 6, line 28 of the application. Thus, in order to make and use the invention, a person need only know how to program a computer to implement this equation. Since the equation merely involves arithmetic calculations, such programming is well within the capability of those having only the most basic level of skill in the art. It is not seen where any undue experimentation would be required to perform this task.

Of course, the execution of the equation requires the prior calculation of the weighting value a_{ij}. However, the application explicitly describes this calculation as well, as can be seen by the equations appearing on page 7 of the application. This

equation, in turn, requires the calculation of two values, namely f(v) and w(i,j). Again, the application provides specific examples of these values. With respect to the baseline value w(i,j), page 7, lines 11-12 disclose that this value could be the same as the value y(i,j) of the pixel being updated. The specification goes on to disclose that, more preferably, the baseline value is a function of y(i,j) in which high frequency components are reduced, "such as an average over the pixels neighboring (i,j)." The application clearly discloses that the baseline value can be calculated by determining the average value of pixels within a neighborhood. Figures 4a-4c depict three specific examples of neighborhood functions that can be employed. Thus, no experimentation is required to obtain the baseline value w(i,j). One need only follow the example that is explicitly set forth in the specification.

Similarly, the application sets forth four specific examples for the function f(v), at page 13, lines 3-10. Furthermore, in Tables 5-7 appearing on pages 13-16, the application provides specific results that are obtained with each of these different functions, for each of the three different neighborhood functions of Figures 4a-4c, and different values for the parameter "k". By virtue of this disclosure, a person of ordinary skill in the art is provided with more than enough information to determine, for a given iteration, which of the four possible functions and three disclosed neighborhoods is the most appropriate for any desired effect to be achieved.

In view of the foregoing, it can be seen that the specification provides sufficient information for a person of ordinary skill in the art to make and use the claimed subject matter without requiring *any* experimentation on the part of that person. The only skill that is required is the ability to program a processor to perform arithmetic calculations, all of which are explicitly set forth in the specification. The specification complies with the requirements of the first paragraph of 35 U.S.C. § 112, and claim 22 is fully supported thereby.

C. The Rejections Under 35 U.S.C. §112, Second Paragraph

1. Claims 2-9, 11, 12 and 19

These claims stand rejected under the second paragraph of 35 U.S.C. §112, as being indefinite. The Office Action states:

> Claim 2 recites, in lines 8-9, "a significance coefficient that is based upon the value of *that pixel*" [emphasis added]. Does "that pixel" refer to the individual pixel recited earlier in claim 2, or does "that pixel" refer to each pixel of the neighborhood as also recited earlier in claim 2. Claim 2 could be interpreted either way.

The rejection appears to be asserting that the term "that pixel" renders the claim indefinite. Appellant submits that this assertion is based upon a consideration of the term in the abstract, rather than reading it in context. Specifically, the entire phrase at issue is "deriving for *each* pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel." When this phrase is read as a whole, it is submitted to be apparent that the antecedent for "that pixel" is the recitation of "each" pixel of the neighborhood.

Furthermore, the meaning of the term is supported by the record. As stated in the rejection itself, the Examiner assumes that the term "that pixel" refers to each pixel of the neighborhood "since such an interpretation is consistent with the specification and has been put forth previously by Applicant." Thus, when the record is read as a whole, the meaning of the term is clear to those reading the claim.

2. Claims 14, 15 and 21

The rejection of these claims under the second paragraph of 35 U.S.C. §112 is based on the same grounds as the rejection of claims 2-9, 11, 12 and 19, namely the intended meaning of "that pixel." The rejection again acknowledges that it is appropriate to interpret the term to refer to each pixel of the neighborhood, since it is consistent with the specification and the record. Consequently, when viewed in context, the meaning of the term is clear, and the rejection is not supportable.

3. Claim 16

Claim 16 was also rejected on the same basis as the claims discussed in the preceding two sections of this Brief, namely the meaning of "that pixel." For the reasons presented above, the meaning of the term is clear, from both the context of the claim itself and the record as a whole.

4. Claim 17

Again, claim 17 is rejected on the same basis as the claims discussed above, namely the meaning of the term "that pixel." For the reasons presented above, the rejection is not sustainable.

D. The Rejection Under 35 U.S.C. §102

Claims 2-4, 16 and 19 stand rejected under 35 U.S.C. §102, as being anticipated by the Fan patent. While that patent describes an inverse halftoning technique, it does not disclose, nor otherwise suggest, the subject matter of the rejected claims.

Claim 2 recites the initial step of defining a set of neighborhood pixels of an individual pixel being processed, with the set of neighborhood pixels including the individual pixel and a plurality of pixels proximate the individual pixel. The rejection refers to Figure 8A of the Fan patent, which discloses that the pixel being processed x(m,n) has an associated window 702 that includes adjacent pixels 704.

The next step of claim 2 is "deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel". In connection with this claimed subject matter, the rejection refers to the edge enhancement value α, disclosed at column 7, lines 54 to 58 of the Fan patent, as being the claimed significance coefficient. That value is not the same as the claimed significance coefficient. The patent does not disclose that the value α is derived for *each* pixel of a neighborhood, based upon the value of *that* pixel. Rather, it is a fixed value that is selected once, and globally applied to all edge enhancement calculations. Note for example, that α is not represented in the equation on line 52 with indices or the like to indicate that it is specific to a given pixel. It is the same for every calculation of y(m,n), and not varied in accordance with the current values for m and n. As such, there is no disclosure that α is based upon the value of any given pixel.

Since the Fan patent does not disclose this claimed feature, it cannot disclose the next step of claim 2, namely "deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the halftone image value at that neighborhood pixel with the significance coefficient of that neighborhood pixel". In particular, the Fan patent does not disclose that the

reconstructed value of a pixel is a sum of products of the type recited in the claim. Rather, the technique employed in the Fan patent is to determine whether the pixel being processed is in a "flat" region of the image, or at an edge. This determination is made with respect to a threshold value σ, described in the paragraph bridging columns 6 and 7. If the pixel is in a flat region, it is smoothed by averaging it over the pixels of its window, i.e. x*(m,n). If it represents and edge, it is set equal to itself. There is no calculation of products, or summary of such products, in this procedure.

With reference to Figure 4, the Fan patent discloses an alternative technique for processing pixels that represent an edge. That technique is represented by the equation appearing at column 7, line 52. While that equation includes the summing of products, those products are not the same as the products recited in the claim. Specifically, claim 2 recites the product of the halftone image value "at that neighborhood pixel" with the significance coefficient "of that neighborhood pixel." Thus, the value of an individual pixel is multiplied with the coefficient associated with that pixel.

First, as discussed previously, the value α does not represent a significance coefficient associated with a *given* neighborhood pixel. Rather, it is a constant value that is independent of any particular neighborhood pixel.

Second, even if the value α could be considered to be a significance coefficient, the Fan patent does not disclose the calculation of the product of that value with a particular neighborhood pixel. Rather, the value for α is multiplied by the *average* gray level input value for all of the pixels in a window, i.e. x*(m,n). The value α is not multiplied by individual pixels, as recited in the claim.

For at least these reasons, therefore, the subject matter of claim 2 is not anticipated by the Fan patent. Claims 3, 4 and 19 depend from claim 2, and therefore are not anticipated for at least these same reasons.

Claim 16 recites the distinguishing features of claim 2 that are discussed above, namely the derivation of a significance coefficient for each pixel of the neighborhood that is based upon the value of that pixel, and the derivation of a reconstructed value as a sum over the pixels of the neighborhood of a product of the value of the neighborhood pixel with the significance coefficient of that neighborhood pixel. Accordingly, claim 16 is likewise not anticipated.

E. The Rejections Under 35 U.S.C. § 103

1. Claims 1, 5, 11-15, 17, 18 and 20-22

a. Claims 1 and 22

Claims 1, 5, 11-15, 17, 18 and 20-22 stand rejected under 35 U.S.C. § 103, as being unpatentable over the Fan patent in view of the Wong patent. Claim 1 recites a method that includes the step of defining a respective neighborhood, and obtaining a continuous value for each individual pixel by summing the products of weighting values and the binary values of the pixels in the neighborhood of the individual pixel. The claim recites that "the weighting values [are] derived from the binary values of the halftoned image". In rejecting this claim, the Office Action refers to the values α and (1- α) as being weighting values. For the reasons discussed previously, in connection with claim 2, these values are not derived from the binary values of the halftoned image. The Fan patent does not disclose any relationship between the value that is chosen for α and the values of pixels in an image. Rather, it is a value that is selected by the user, in dependence upon the amount of edge enhancement that is to be applied (column 7, lines 54-56). The Fan patent does not disclose that this value is "derived" from binary values of a halftoned image.

In rejecting the claim, the Office Action refers to the difference values dif0 and dif1 described at column 6, lines 52-58 of the Fan patent. These difference values do not affect the *value* that is assigned to α. Rather, as illustrated by the equation set forth in column 7, line 52, these difference values are used to determine which one of the two adjacent windows of pixels, $(m-T_x)$ or $(m+T_x)$, is to be employed in the calculation. In either case, the value for α remains the same. Hence, the Office Action has not shown that the value for α is derived from the binary values of the halftoned image, as recited in claim 1.

Claim 1 recites multiple iterations, in which the value that is obtained for an individual pixel is based upon values obtained in a previous iteration. The Office Action acknowledges that the Fan patent does not disclose such an iterative approach, and relies upon the Wong patent. The Office Action proposes to modify the disclosure of the Fan patent, in view of Wong, "such that only one location is within the pixel window for pixel processing." (Office Action at page 15, last partial

paragraph) However, modifying the disclosure of the Fan patent in such a manner would destroy the principal of operation disclosed in that patent.

As discussed previously, the basic principal of operation disclosed in the Fan patent is to determine whether a pixel lies within a flat region of the image, or in the vicinity of an edge. If the pixel is in a flat region, smoothing is desirable, so the output value of the pixel is set equal to the average value of the pixels in its window. If the window is modified to contain only a single pixel, as suggested in the Office Action, the desired smoothing would not be obtained. Rather, the pixel would only be averaged with itself, and its value would be unchanged. Consequently, no matter how many iterations are performed, the value of the pixel would always stay at its original value.

Accordingly, it would not be obvious to combine the disclosures of the Fan and Wong patents in the manner suggested in the Office Action. Doing so would destroy the principal of operation disclosed in the Fan patent.

Furthermore, even if the disclosures of the two patents are combined, the Office Action still has not shown that the references teach or suggest all the claim limitations, as required for a prima facie case of obviousness. Among other distinctions, there is no showing that weighting values are derived from the values of pixels in an image, as recited in claim 1.

For at least these reasons, the rejection of claim 1 is not sustainable. Claim 22 is an apparatus claim that recites these same distinguishing features. Therefore, the rejection of this claim is also not supported by the references.

b. Claims 13 and 20

Claim 13 recites a method which includes the steps of defining a set of neighborhood pixels of an individual pixel, and, "for each pixel of said first neighborhood," deriving a *respective* significance coefficient. The use of the term "respective" means that each pixel of the neighborhood has its own significance coefficient derived for it. In rejecting this claim, the Office Action again relies upon α as being a significance coefficient. As discussed previously, the value for α is not derived for "each" pixel of a neighborhood. Nor is there a respective α value for each pixel in a neighborhood. Rather, there is only a single value of α that is used for *all* of the pixels in the image being processed.

Claim 13 recites the further step of deriving a first reconstructive value of an individual pixel as a sum over the neighborhood pixels of a product of the halftone image value "at that neighborhood pixel" with the respective significance coefficient "of that neighborhood pixel". For the reasons presented previously in connection with claim 2, the Fan patent does not disclose this claimed subject matter. Specifically, it does not disclose that the image value of an individual neighborhood pixel is multiplied by a significance coefficient associated with that pixel. It only discloses that the global value for α is multiplied by the average gray level input value for all of the pixels in a window. There is no multiplication of individual pixel values with respective significance coefficient values.

Finally, claim 13 recites that M further steps are carried out, in which a significance coefficient is rederived for each neighborhood pixel. The Office Action acknowledges that the Fan patent does not disclose this claimed step, and relies upon the Wong patent for its disclosure of an iterative process. However, even if the Fan patent is modified to employ an iterative process, there is no teaching in either reference that would lead to the claimed subject matter. At best, performing multiple iterations in the context of the Fan patent would only result in further smoothing of the pixels in the flat region, and/or further enhancement of the edges in the image. There is no suggestion, in either of the Fan patent or the Wong patent, that would lead a person of ordinary skill in the art to rederive a significance coefficient during each iteration. As discussed previously, α is a single coefficient that determines the amount of edge enhancement that is to be applied, once an edge has been identified. The Office Action has not identified any teaching in either the Fan patent, or the Wong patent, which suggests that this value should be modified during the implementation of the process. Specifically, there is no suggestion to change the value of α from one iteration to the next. Consequently, even if the general concept of an iterative process is employed in the context of the Fan patent, there is no suggestion to rederive a significance coefficient for each neighborhood pixel during each of the iterations.

Consequently, the Office Action has not established that the references teach all of the elements recited in the claims, even when they are considered in combination. Accordingly, the Examiner has not made a proper showing of a prima

facie case of obviousness, and the rejection of claim 13 is not sustainable. Claim 20 depends from claim 13 and is likewise patentable for at least these same reasons.

c. Claims 14 and 17

Claims 14 and 17 recite similar distinguishing features as those discussed previously. For example, claim 14 recites the step of deriving, for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel. It also recites deriving the reconstructed value of an individual pixel as a sum of a product of an image value at a neighborhood pixel with the significance coefficient of that neighborhood pixel. Claim 17 recites these same features. For the reasons discussed previously, these claimed features are not disclosed by the Fan patent. Consequently, the Office Action has not established that the references, even when combined, teach or suggest all the claim limitations, as required for a prima facie case of obviousness. Hence, the rejection of claims 14 and 17 is not sustainable. For at least these same reasons, the rejection of dependent claims 15 and 21 is also not supported.

2. Claims 6-9

Claim 6 recites that, for each individual pixel, the significance coefficient for each of its neighborhood pixels is a decreasing function of the absolute difference between the halftone value of that neighborhood pixel and the baseline value for the individual pixel. In rejecting this claim, the Office Action alleges that the Fan patent discloses that the significance coefficient, α, is an increasing function of the absolute difference between the halftone value of a neighborhood pixel and the baseline value for an individual pixel. Specifically, with reference to column 7, lines 48-58, the Action states "For an increasing absolute difference between a pixel and a neighboring pixel, the value of the significance coefficient (α) increases". It is not apparent from the Office Action how the reference is being interpreted to disclose this concept.

First, the Office Action does not identify where, in this passage, the Fan patent discloses the calculation of the difference between a pixel being processed, e.g. x(m,n), and its neighboring pixels. Second, even if the patent could be

interpreted to disclose such a concept, there is no disclosure that the value for α is dependent upon this difference. Specifically, there is no disclosure that α increases or decreases in dependence upon such a difference. As discussed previously, the selection of the value for α is independent of the values of any individual pixels in the image. Rather, it is a factor that is chosen by the user, and applied globally to the entire image.

For at least these reason, therefore, the Office Action has not established a prima facie case of obviousness that would support the rejection of claim 6. For at least these same reasons, the rejection of claims 7-9 is also not supportable.

F. Conclusion

For the reasons presented above, the rejections of the claims are not properly supported in this statute, and should be reversed.

VIII. Claims Appendix

See attached Claims Appendix for a copy of the claims involved in the appeal.

IX. Evidence Appendix

(none)

X. Related Proceedings Appendix

(none)

Respectfully submitted,

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VIII. CLAIMS APPENDIX

The Appealed Claims

1. A method for converting a halftone image in which each pixel takes one of two binary values, into an image in which each pixel takes a continuous value, comprising:

for each pixel, defining a respective neighborhood containing that pixel and other pixels;

in a first iteration, obtaining for each individual pixel a continuous value by summing the products of weighting values and the binary values of the pixels in the neighborhood of the individual pixel, the weighting values being derived from the binary values of the halftoned image; and

in further iterations, obtaining for each individual pixel a continuous value by summing the products of the weighting values and the continuous values of the pixels in the neighborhood of the individual pixel obtained at the previous iteration, the weighting values being derived from the continuous values obtained in at least one previous said iteration.

2. A method for converting a halftone image having a halftone value for each of a plurality of pixels, into a reconstructed image which for each of said pixels takes on one of more than two possible values, comprising for successive individual pixels:

defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;

deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel; and

deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the halftone image value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.

3. A method according to claim 2 in which said halftone image is derived from an original image having a continuous value for each pixel, and, for each individual pixel, said significance coefficient of each neighborhood pixel is an indication of the likelihood that the value of that neighborhood pixel in the original image is correlated with the value of the individual pixel in the original image.

4. A method according to claim 2 in which, for each individual pixel, said step of deriving a significance coefficient for each neighborhood pixel includes: deriving a baseline value for the individual pixel, and deriving said significance coefficient as a function of the halftone value for the image at that neighborhood pixel and of the baseline value for the individual pixel.

5. A method according to claim 4 in which the baseline value for the individual pixel is derived by low pass filtering of the halftone image.

6. A method according to claim 5 in which, for each individual pixel, the significance coefficient for each neighborhood pixel is a decreasing function f(v) of the absolute difference (v) between the halftone value at that neighborhood pixel and the baseline value for the individual pixel.

7. A method according to claim 6 in which f(v) is a non-linear function.

8. A method according to claim 6 in which f(v) is a continuous function.

9. A method according to claim 8 in which f(v) is a function of the form $f(v)= a(1-v/b)^k$ where a and b are predefined numbers and k is a predefined integer.

11. A method according to claim 2 comprising a further step of forming an enhanced reconstructed image as a linear combination of said reconstructed image and a continuous image derived from said halftone image by a second image reconstruction method.

12. A method according to claim 11 in which said second image reconstruction method is a low pass filter.

13. A method for converting a halftone image having a binary value for each of a plurality of pixels, into a reconstructed image which for each of said pixels takes on one of more than two possible values, comprising for successive individual pixels:

defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;

deriving for each pixel of said first neighborhood, a respective significance coefficient; and

deriving a first reconstructed value of the individual pixel as a sum over the neighborhood pixels of a product of the halftone image value at that neighborhood pixel with the respective significance coefficient of that neighborhood pixel; and

M further steps, m=1,..., M ($M \geq 1$), of:

for successive individual ones of said pixels:

rederiving a significance coefficient for each neighborhood pixel; and

deriving an (m+1)-th reconstructed value of the individual pixel as a sum over the neighborhood pixels of the product of the m-th reconstructed value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.

14. A method for converting a halftone image having a halftone value for each of a plurality of pixels, into a reconstructed image which for each of said pixels takes on one of more than two possible values, comprising:

preprocessing the halftone image by a filtering algorithm to derive a preprocessed image having a preprocessed image value for each of said pixels; and

for successive individual pixels:

(i) defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;

(ii) deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel; and

(iii) deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the preprocessed image value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.

15. A method according to claim 14 in which, for each individual pixel, said step of deriving a significance coefficient for each neighborhood pixel includes: deriving a baseline value for the individual pixel, and deriving said significance coefficient as a function of the preprocessed value for the image at that neighborhood pixel and of the baseline value for the individual pixel.

16. A method for enhancing first image having a first value for each of a plurality of pixels, into an enhanced image, comprising for successive individual pixels:

defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;

deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel; and

deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the first value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.

17. A method for enhancing a first image having a first value for each of a plurality of pixels to form an enhanced image, comprising:

preprocessing the first image by a filtering algorithm to derive a preprocessed image having a preprocessed image value for each of said pixels; and

for successive individual pixels:

(i) defining a set of neighborhood pixels of the individual pixel, the set of neighborhood pixels including the individual pixel and additionally a plurality of pixels proximate said individual pixel;

(ii) deriving for each pixel of the neighborhood, a significance coefficient that is based upon the value of that pixel; and

(iii) deriving the reconstructed value of the individual pixel as a sum over the pixels of the neighborhood of a product of the preprocessed image value at that neighborhood pixel with the significance coefficient of that neighborhood pixel.

18. A computer program product which is readable by a computing device to cause the computing device to perform a method according to claim 1.

19. A computer program product which is readable by a computing device to cause the computing device to perform a method according to claim 2.

20. A computer program product which is readable by a computing device to cause the computing device to perform a method according to claim 13.

21. A computer program product which is readable by a computing device to cause the computing device to perform a method according to claim 14.

22. An image enhancement apparatus for converting a first image into an enhanced image, comprising a processing device having:

an image receiver for receiving said first image;

and an image processor for which performs the steps of:

for each pixel, defining a respective neighborhood containing that pixel and other pixels;

in a first iteration, obtaining for each individual pixel a continuous value by summing the products of weighting values and the binary values of the pixels in the neighborhood of the individual pixel, the weighting values being derived from the values of the first image; and

in further iterations, obtaining for each individual pixel a continuous value by summing the products of the weighting values and the continuous values of the pixels in the neighborhood of the individual pixel obtained at the previous

iteration, the weighting values being derived from the continuous values obtained in at least one previous said iteration.